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GOVERNMENT OF MYSORE

REPORT

OF

THE COMMITTEE OF ENQUIRY

Constituted by Government to investigate into the causes for the Breaches of Sangenahalli and Thuppadahalli Tanks in Jagalur Taluk, Chitaldrug District in October 1953

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GOVERNMENT OF MYSORE

PUBLIC WORKS DEPARTMENT

G.O. No. P. W. 13208-15—Irn.—5-53-9, dated 5th March 1954.

Report of the Committee of Enquiry.

Reviews the —— constituted by Government to investigate into the causes for the breach of Sangenahalli and Thuppadahalli Tanks in Jagalur Taluk, Chitaldrug District.

READ—

Government Order No. P. W. 7902-6-Irn. 5-53-7, dated 27th November 1953, constituting a Committee to investigate into the causes for the breach of Sangenahalli and Thuppadahalli Tanks, Jagalur Taluk.

Letter dated 25th January 1954 from the Chairman of the Committee, forwarding the Report of the Committee.

ORDER THEREON No. P.W. 13208-15-IRN. 5-53-9, BANGALORE, DATED, THE 5TH MARCH 1954.

In the order read above Government constituted a Committee with the personnel noted below to enquire into the causes of the breach of Sangenahalli and Thuppadahalli Tanks and to furnish a report to Government :—

Sri L. Siddappa, B.A., LL.B., M.L.A., (Chairman)

Sri H. R. Guruv Reddy, B.A., LL.B.

Sri C. R. Iyengar, B.A.,B.E.

2. The Committee have, after conducting necessary inspections and after making enquiries, forwarded a report covering mainly the following matters :—

(1) the circumstances that led to the breaches ;

(2) the nature and value of the damage and the remedial measures ; and

(3) the nature of the responsibility of those connected with the works at the various stages and other allied matters.

In a separate note attached to the main report, two of the Members of the Committee, namely, Sriyuts L. Siddappa and H. R. Guruv Reddy, have dwelt further on the last mentioned aspect of the matter.

3. In regard to Sangenahalli Tank, the causes ascribed by the Committee for the breach are :—

(1) inadequate foundation and keying of the bund well into the ground ;

(2) imperfect consolidation and want of picking of the newly rolled surface to get a thorough mix of bund material to a uniform homogeneous consistency ;

(3) poor and porous soil with which the bund filling material is made ;

(4) want of waterproof consolidated gravel backing to revetment to afford it support and poor quality construction with round boulder stones without keying the face stone to the back ; and

(5) quick rise of water level in the new lake.

4. The Committee have observed that the circumstances go to show that the damage was due to weak construction and not to heavy rainfall, and that the bund in its condition just prior to the breach was unprepared to receive and keep any water storage. The Committee have suggested certain remedial measures and have estimated the cost of making good the damage and bringing the tank to working condition at Rs. 1,25,000 (subject to variations in the light of the detailed estimates to be prepared).

5. The Committee have found that the causes for the breach of the Thuppadahalli Tank were :—

(1) Heavy rainfall and rapid filling of the lake ;

(2) Very inadequate free-board at the time of the breach ;

(3) Incomplete revetment construction ;

(4) Poor black soil with which the bund is made;

(5) Want of consolidation ; and

(6) Want of forethought on the part of the Engineers at the spot at the time the breaches occurred.

6. In this case also, the Committee have suggested remedial measures and have estimated the cost of repairing the tank at Rs. 1,35,000.

7. Government agree with the observations and findings contained in the report of the Committee. Further action will be taken in the light of the

Committee's report to assess the responsibility of these connected with the works from time to time and to take suitable measures in that behalf. The Chief Engineer is requested to take necessary action immediately regarding the remedial measures proposed by the Committee in respect of both the tanks.

8. Government wish to thank the Committee for the valuable services rendered by them.

9. The report of the Committee is appended.

D. K. SRINIVASACHAR,
Secretary to Government,
Public Works Department.

Tc—The Compiler, *Mysore Gazette.*
The Chairman and Members of the Committee.
The Chief Engineer of Mysore, Bangalore.
The Superintending Engineer, Shimoga Circle.
The Deputy Commissioner, Chitaldrug District.
PRESS TABLE.

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REPORT OF THE COMMITTEE OF ENQUIRY CONSTITUTED BY GOVERNMENT TO INVESTIGATE INTO THE CAUSES FOR THE BREACHES OF SANGENAHALLI AND THUPPADAHALLI TANKS IN JAGALUR TALUK, CHITALDRUG DISTRICT IN OCTOBER 1953.

MEMBERS OF THE COMMITTEE.

1. Sri L. Siddappa, B.A., LL.B., M.L.A. .. Chairman
2. Sri H. R. Guruv Reddy, B.A., LL.B. .. Member
3. Sri C. R. Iyengar, B.A., B.E. .. Member

Government in their Order No. P.W. 7902-6—Irn. 5-53-7, dated 27th November 1953, constituted this Committee to investigate into the causes for the breaches of Sangenahalli and Thuppadahalli tanks in Jagalur Taluks, which were under construction with the following terms of reference :—

(i) to examine the circumstances that led to the breaches ;

(ii) to assess the extent and value of damages ; and

(iii) to make a report to Government in this behalf.

First Meeting of the Committee was called for by the Secretary to Government, Public Works Department, to be held in the Chambers of the Hon'ble the Chief Minister on 27th November 1953 to discuss the facilities needed and the staff to be provided to the Committee. After this meeting, the Committee met again on 30th November 1953 to draft a programme of work and it was there decided that the Committee should inspect the breached works at Sangenahalli and Thuppadahalli on 10th and 11th December 1953 respectively.

Accordingly, the Committee arrived at Chitaldrug on the evening of 9th December 1953 and inspected the

two breached tanks—Sangenahalli and Thuppadahalli on the 10th and 11th December 1953 respectively between 9 A.M. and 1-30 P.M. each day. A second inspection was made on 4th January 1954 of both the tanks and representations made by the public were heard by the Committee.

SANGENAHALLI TANK

Sri Mulka Govinda Reddy, M.L.A., accompanied the Committee Members during their inspection of the Sangenahalli tank on 10th December 1953.

General

The bund is thrown across the Jinagihalla and has a length of 44 grades. The maximum depth of water in the central portion is 51 feet (R.L. 2146.00 *minus* R.L. 2095.00=51 feet) at the point of the breach. The bund cross section has front slope of 1½ : 1 and rear slope of 2 : 1 with a berm in the lower reach in deep portions.

Rainfall and Weir Design

The rain gauge records show that when compared with the average annual rainfall for the past 35 years the district average up to the end of October 1953 is 4.65 inches extra. (End of October 1953—24.92 inches; average for 35 years 20.27 inches; 4.65 inches excess). Though the district average is thus seen to be higher, the rainfall average for the Chitaldrug and Challakere Taluks where this tank catchment lies, conforms more or less to 35 years' average. It is to be anyhow stated that all over the Chitaldrug District, the rainfall during the second fortnight of October 1953 was above the average and this tank began to receive its supply during the last week of October 1953. A copy of the relevant rain gauge records furnished to the Committee by the Executive Engineer is appended (Appendix I).

The catchment area is 300 square miles total and 80 square miles independent with 4 major tanks above. The sanctioned design provides for a 400 feet length of

weir with a spill head of 4 feet to allow a computed discharge of 9,500 cusecs. The sanctioned levels are :—

Weir Crest Level—R.L. 2142.00

Tank Maximum Water Level—R.L. 2146.00

Top of Bund Level—R.L. 2150.00 with a free board of 4 feet above Maximum Water Level.

Condition of the bund during the time of inspection

The earth material used for the bund is of poor quality throughout the entire length. It has very little cementing material and conforms more to the nature of coarse sand with granular rocky lumps interspersed with layers of black soil obtained from tank bed. The consolidation in the bund cross section is very poor, and in the same cross section, at either end the earth laid is quite loose. The crest of bund appears to have received recent attention being consolidated with a small coating of fresh earth, probably to close up longitudinal fissures which developed during the tank filling. This should have been left as it was for the Committee to examine. The revetment may be stated to be resting on loosely consolidated earth.

As regards consolidation, it must be stated that the alternating layers of poor quality earth have received no consolidation worth mentioning nor any adequate watering arrangements for consolidating the earth seem to have been made. A number of trial pits with an auger drill were got excavated along the entire bund and an extract of the report received from the Executive Engineer (Appendix II) indicates that the percolation through the bund body is alarmingly high.

Bund Earth Work

The earth work in the bund cross section consists of layers of earth laid in thickness of 9 inches to 1 foot and loosely consolidated without raking and mixing up the earth in the layers into one consolidated mass. Layers of black soil and sandy rocky excavated earth are seen layer upon layer with dividing planes. The Chief Engineer's report accompanying the estimate indicates that good

gravel is available in the bed for foundation for seating the bund, but though it cannot be definitely stated, it looks as if the bund seating along its entire length has not been taken deep enough to key the bund well in its foundations. This is clear at the site of the breach where the foundation is superficial, nor are any grip cuts for seating of bund visible. On the other hand, at the breach site in one flank the seat shows itself as a flat junction at ground level only, with a thin interstrip of fine sand at the junction across the entire cross section.

Revetment

Revetment generally excepting in the end grades, shows signs of settlement and in the centre grades it has settled into an irregular flattened and floating mass after slipping away from the loose front bund slope. No gravel backing appears to be used as a backing for revetment. Since the tank began to fill on the 27th and 28th October 1953, the pooling up of water on the front side inside the lake, even during this short period, was sufficient to penetrate through the body of the bund consisting of loosely consolidated bund earth work which got saturated with water and ended in a general slip of the front slope. This resulted in the general failure of the revetment in the centre grades.

Revetment from grade 12 to grades 27 and 28 has slipped down up to the breach in 27 and 28 grades. Revetment has lost shape in grades 29 and 30. There is a general complete failure in the centre grades.

Immediate Causes of Breach

As stated above, in the centre grades where the water pressure is about 30 feet average, the water immediately pierced through into the heart of the bund which got thoroughly saturated. Leaks appeared even on the top of the berm at R.L. 2129.00 thrown behind in the centre portion as a backing to the bund. At the time of the breach at 8 A.M. on 28th October 1953, this leak in the 28th grade rapidly developed and the breach occurred. Due to poor quality earth laid in layers with inadequate consolidation, the saturation gradient appears

to be about one in six rather than one in four. This is clear since the leak at the breach has not appeared at the bottom of the stream bed at R.L. 2110.85 but even on the top of the berm itself (R.L. 2129.00). The Engineers at the spot mentioned that the failure of the revetment which is general and extends from grade 28 to 12 is due to a sucking action at the flanks due to sudden rush of water after the breach. We do not agree with this point of view and we consider that construction of the revetment without keying in and wedging of stones of suitable sizes into the backing, want of thoroughly well consolidated gravel backing behind the revetment, and poor consolidation without adequate watering are responsible for the damages. In fact, in grades far remote from the site of the breach, this action of a general settlement can be observed even though it has nothing to do with the proximity of the breach and the water pressure is no more than 10 to 12 feet. Summing up, the main causes for the breach appear to be:—

(*a*) Inadequate foundation and keying the bund well into the ground;

(*b*) Imperfect consolidation and want of picking the newly rolled surface to get a thorough mix of bund material to a uniform homogeneous consistency;

(*c*) Poor and porous soil with which the bund filling material is made;

(*d*) Want of water-proof consolidated gravel backing to revetment to afford it support and poor quality construction with rounded boulder stones without keying the face stone to the back; and

(*e*) Quick rise of water level in the new lake.

Remedial Measures

(1) The bund can be considered in 3 compartments, the 1st section—grades 1 to 12, the middle section —grades 13 to 32 and the end section—grades 33 to 44. The bund in the 1st and the 3rd sections may be retained as it is without disturbing the front revetment. The top

and rear may be encased with one foot thickness of excavated material from weir draught channel.

(2) In the centre or middle section :—

(*a*) A longitudinal trench of sufficient width should be excavated and a puddle wall of well kneaded clay should be laid and keyed into bottom foundation. This is considered very necessary to prevent water percolation through the bund and to safeguard against leaks. The top of puddle wall may be R.L. 2140.00. The axis of the puddle wall may be kept about 1½ feet towards the water face than along the centre line itself.

(*b*) The entire revetment in these centre grades should be pulled out, the bund earth front slope should be thoroughly consolidated, consolidated gravel backing given and revetment reconstructed with suitable stones keying the courses well with the rear portion as per standard specifications.

(*c*) This new tank across the Jinagihalla has in its upper reaches :—

(i) Bheemasamudra tank—Capacity 1,095 units.

(ii) Shivaganga Abbanayakanahalli—Capacity 327 units.

(iii) Talya tank—Capacity 202 units.

(iv) Katral tank—Capacity 517 units.

As such, this tank with its capacity of 1,600 units, forms the 5th major tank in the series. In the calculation for the length of the waste weir of 400 feet for this tank, for 4 feet depth of spill, a co-efficient of 250 has been taken in the Ryves Formula :—

$Q=250\times300^{2/3}-1/5\times250\times80^{2/3}=10,270$ cusecs.

$Q=3.33\ L\ h^{3/2}$

Or

L, length of weir for 4 ft. depth of spill—386 ft. or say 400 ft.

In our opinion, this coefficient is low and the weir length should be increased to 450 ft. corresponding to a coefficient of 300.

$$Q = 300 \times 300^{2/3} - 1/5 \times 300 \times 80^{2/3} = 12{,}336 \text{ cusecs.}$$

$$\text{Giving } L = \frac{12336}{3.33 \times 4^{2/3}} = 466 \text{ ft. or say } 450 \text{ ft.}$$

Further, being the 5th tank in the series it is desirable to have a breaching section on the flank of the waste weir on the off side of the bund so that in case of emergency this breaching section would function and safeguard the tank. Now that a permanent waste weir of 400 feet has been built up and completed in every respect, it is suggested that the extra length of 50 feet proposed may be included in the breaching section which may be of 150 feet length. The free-board above maximum water level may also be increased to 5 feet.

It is to be stated that for the upper tanks in this valley, the free board above maximum water level provided for the Talya tank and Shivaganga Abbanayakanahally tank are 4 feet and 5 feet respectively. In addition to the usual provision of waste weir length in the above two tanks breaching bund sections of 82 feet and 100 feet respectively have been provided as per report dated 30th December 1953 received from the Executive Engineer, as an extra flood disposal precaution. Such a provision as suggested above for the Sangenahalli tank is, therefore, very necessary.

(*d*) For the full area of irrigation to be developed under this new tank, it would take a few years, say about 5 or 6 years after the tank fills. There will be no need to effect full storage at once and it is desirable to keep the weir crest 3 feet lower at the start, utilising the reduced storage for irrigation. Accordingly, the 400 feet length of the masonry weir wall may be lowered by 3 feet for the time being, the crest being kept at R.L. 2139.00. This will give a chance for the bund to go on settling during a period

of 4 or 5 years in which time any small leaks or weak spots, if any, can be studied and remedial measures also taken.

Cost of making good the Damages

The estimate prepared and submitted by the Executive Engineer, Davangere Division, provides for breach filling and replacing the dislodged revetment in required places. Based on the findings contained in the above note, the following rough abstract of cost for making good the damages of the bund is provided :—

	Rs.
(i) Cost as per Executive Engineer's estimate already submitted for sanction	70,000
(ii) Cost of providing a casing material to protect rear slope in sections 1 and 3	2,000
(iii) Longitudinal trench in the middle section and filling in with clay puddling from grades 13 to 32	27,000
(iv) Removal of revetment, consolidation after stepping front slope and formation to profile and reconstructing revetment	20,000
(v) Miscellaneous, such as riprap fill in breach portion, providing breaching section at weir flank end, and increased free board ..	4,000
	1,23,000
	or say 1,25,000

Note.—1. This abstract figure of cost has to be finalised by working out details of quantities and prevailing rates.

2. This figure does not also take into account the damage caused to lands below by flooding, silting and erosion.

Twenty-two irrigation wells are reported to be damaged and silted up.

In conclusion, it is to be stated that Sangenahalli tank failed not on account of any heavy rainfall in the upper catchment but due to weak construction as indicated in the above note, *viz.* :—

(*a*) poor and inadequate foundation ;

(*b*) bad and porous soil ;

(*c*) poor consolidation without adequate watering ;

(*d*) bad revetment construction with boulders on an unconsolidated earth slope without gravel backing.

The fact that within about 12 hours after the receipt of water into the lake, the bund breached even when the water level was 2½ feet below the weir crest and about 7 feet below designed maximum water level, indicates how unprepared the bund was in its present condition to receive and keep any water storage.

THUPPADAHALLI TANK

Mushir-Ul-Mulk Sri J. Mohamed Imam was kind enough to accompany the Committee Members during the inspection of Thuppadahalli tank on 11th December 1953.

General

This bund is across the Chinnahagari, the length of the bund being 62 grades. There are 16 tanks in the upper catchment and the Bharamasagara and Anaji tanks are two major tanks immediately above this tank. The maximum depth of storage is 33 feet in grade 19-20 (R.L. 2116.00 *minus* R.L. 2083.00=33 feet). The front and rear slopes are 1½ : 1 and 2 : 1 respectively, with a berm at the back in deeper portions.

Rainfall and Weir Design

There was more intense rainfall in this catchment than in the Sangenahalli tank catchment during October 1953.

The district average up to the end of October 1953 during the last 35 years is 4.65″ above the average. During this year in this tank upper catchment, the observed rainfall is 7.07″ during the last week alone of October 1953 in the Jagalur taluk and on the night of 29th October 1953 the rainfall at Bilichodu was 4.5″. It is, therefore, reasonable to conclude that the rainfall during the month of October 1953 which occurred in the upper catchment of this new tank has been the highest observed over and above the 35 years' record during the month. The hydrograph of this peak flood would, perhaps, serve as a record for weir designs in this valley for later constructions. It is also to be noted that from 28th October onwards, the two major tanks in the upper catchment, *viz.*, Bharamasagara and Anaji were full and discharging.

The total catchment area at Thuppadahalli tank bund site is 198 sq. miles and the independent catchment is 65 sq. miles. "C" in Ryves Formula is taken as 300, and the Chief Engineer in his report to Government accompanying the statement submitted for sanction has provided a weir length of 365 feet for 4 feet depth of maximum spill and a computed discharge of 9,200 cusecs. The salient sanctioned levels are :—

Weir Crest Level	..	R. L. 2016.00
Tank Maximum Water Level	..	R. L. 2020.00
Top Level of Bund	..	R. L. 2023.00

thus allowing a free board of only 3 feet above the Maximum Water Level the designed tank capacity being 1,175 units.

Condition of bund during inspection

A 15 ft. width of cut was made in grade 57, with a view to allow the water pooled up in the lake to flow out, the depth here, being only 2½ feet. There was no point in making this cut since the discharge was negligible.

Excepting in the very end grades, the bund has developed longitudinal cracks along its entire length. At

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the ends, these fissures are an inch to two in width and easily extend to 3 feet depth. Towards the centre grades, the fissures are wide and gaping, and near the breaches they are even 6" wide and extend quite into the heart of the bund. Sri J. M. Imam who seems to have gone to the spot both before and after the breach has stated in his note that he has given to the Committee, that these fissures had developed considerably and the width of some of them was more than a foot and the revetment had collapsed in many places.

The bund earth is mostly of black soil available in the submersible water spread area. The consolidation is poor and in the same cross section the end consolidation is poorer than in the centre portion. As soon as water was received into the lake, there has been a wholesale longitudinal shear of front face of the earth work causing the front portion to vertically shear off from the middle portion ending in these longitudinal cracks. This shearing of the front face and the formation of the longitudinal cracks are very marked from grades 14 to 42 and even during the time of inspection the process of failure was noted to be still progressive.

Revetment

The same remarks as in the case of Sangenahalli tank apply and the whole front slope in the centre grades is a loose disjointed and irregular floating heap of boulders in various stages of settlement. Thinking that a parallel flow of water at the revetment at the site of the breaches may have caused a general failure and settlement of the revetment in grades 14 to 42, the Engineers at the spot were found to be constructing a stone pitching on the tank bed at the junction of the revetment toe ranging from 8 to 10 ft. wide in a few places. We consider that this has no supporting effect, and is in no manner a remedy. The earth used for the bund is generally black soil and the revetment is laid directly on this unconsolidated earth slope without any gravel backing. Excavated earth from the weir channel is available, and could be used as a casing material for the bund, particularly on the rear side to protect the rear slopes from scour.

Revetment in grades 11 to 14 is built only up to ½ height. In grade 15 it has lost shape. In grade 15 it is only 10' high from bed of tank and it has slipped down. In grade 17 it has lost shape. In grade 18 next to breach the bund has been pulverised.

In grades 22, 23 and 24 there are long fissures. The revetment has lost shape in these grades. In grade 26 (Part) revetment is not full. In grade 30—31, revetment has lost shape. Part of it has collapsed. In grades 32 and 33 all the revetment has collapsed. In grade 34 it has lost its shape.

In grades 34—35 revetment is only half in height. In grades 35 to 43 revetment has lost shape.

Breach No. (1)

This is in grades 29 and 28 and is 280 feet long. The maximum water storage at this point is only 21.5 feet (R. L. 2116.00 *minus* R. L. 2094.50=21.50 feet). The flanks show that the longitudinal shear is great, and the torn earth work is deposited in a mass of debris. In grades 27, 26 and 25 next to this breach, the longitudinal fissures are observed to be quite 6 inches wide.

From the records of Thuppadahalli tank, we find a report dated 12th May 1951 from the Executive Engineer, Davangere Division and countersigned by the Superintending Engineer, Shimoga Circle (dated 23rd May 1951) to accompany the Programme of Thuppadahalli Tank works for the year 1951-52. In Para 2 of that report, it is stated that " the programme for the current year is to close the mass puddle trench work in grades of 19 and part of 29 along with constructing the Central masonry core-wall, and to continue the same on soft rock foundations in the halla grades of 20 and 21 also, where already the bank is raised in partial section to prevent any likely seepage owing to want of hard foundations for the bank raised in main halla portion."

During our inspection on 10th December 1953 and 4th January 1954, we did not notice any masonry core

wall either in existence or being washed out in grade 29. Therefore, it is a matter for verification by further investigation, if necessary, whether such a masonry core wall was constructed here or not.

Breach No. (2)

This is in grades 19, 20 and 21 and is 300 feet long; but, after dressing the edges the effective length may be 400 feet. The breach flank presents a sight which is riddled with cracks and the whole mass has settled down into an unshapely heap of debris. The whole thing has to be removed over the entire section and reconstructed from the foundations. The depth of water here is 33 feet (R. L. 2116.00 *minus* R. L. 2083.00=33 feet). Being a deep breach, where a comparatively higher pressure of water obtains, care in filling up the breach appears necessary. Thorough bonding between old and new work is to be effected, and a puddle core trench and a wall are also necessary.

At the flank of the weir, due to a weir discharge depth of 5 feet of water on the 30th October 1953, the grades next to weir flank have been eroded and at the time of inspection, the repair work was on hand. There was not much evidence of any good consolidation work noticed in these grades either.

Immediate Causes that led to the Breach

The immediate causes of the breach may be stated to be the sudden in-flow into the tank on the 28th and 29th October 1953, as a consequence of which the tank began to rapidly fill and over-flow. This sudden filling of the lake added to poor black soil construction with which the whole bund has been constructed, incomplete work of revetment in many grades, and most important of all the construction of the masonry weir to full designed height even before the bund was raised to full height and designed free board secured, etc., are the causes for this tank breaching.

It is seen that the Thuppadahalli tank was full on the 28th October 1953 and the weir was discharging on

that day, the upper tanks being full. Sri J. M. Imam says in his note that he went to the tank on the 28th October 1953 and noticed that the tank was discharging to a height of about one foot across the waste weir. To start with, the sanctioned free board above the Maximum Water Level of this tank is only 3 feet (R.L. 2023.00 *minus* R.L. 2020.00=3 feet) which is considered a blunder. When the tank began surplusing the incomplete top of the bund was in many grades only at R.L. 2021.75 and in certain other grades it was R.L. 2022.00. As such, the actual free board was only $1\frac{3}{4}$ feet and not 3 feet. Therefore, the bund was unprepared to receive a full flood and the weir crest should have at once been lowered. It is seen that the water level fell down to R.L. 2016.00 by the 29th October 1953 evening and it was only due to the 4.5 inches rainfall at Bilichodu on the night of 29th October 1953, that the water level rose by $5\frac{1}{2}$ feet above the weir crest and overtopped in the low portions of the bund and ended in a breach as per report of the Sub-Division Officer. It is thus clear that the breach was due to the fact that the entire weir was built up to a full height of R.L. 2016.00 excepting a length of 100 feet only which was kept at R.L. 2015.35, while the top of the bund was deficient by $1\frac{1}{4}$ feet in height. If only on the evening of 28th October 1953 the men at the spot had demolished the entire weir length of 365 feet and lowered it to R.L. 2013.00, considering that the bund was not even raised to the sanctioned height and revetment also not complete in many grades, there would, perhaps, have been no breach at all in the bund. It is to be regretted that the Executive Engineer and the Engineer Officers did not visit the spot until the tank breached.

Remedial Measures

(1) The end grades at either end may be left as they are.

(2) In the centre grades from grades 42 to 14, the loose revetment is to be pulled out and the entire work got redone. There is no need for a longitudinal core wall of clay puddle, but instead in the centre grades all the loose earth in the front portion should be removed and the front of the bund should be stepped systematically and layer

after layer of selected gravel should be laid on the front slope to required profile which may be kept to $1\frac{3}{4}:1$ instead of $1\frac{1}{2}:1$. The gravel thickness is suggested to be 6 feet at revetment top level and 20 feet at the base. This remedy would also serve as an efficient protection to the black soil hearting with which the entire bund is made. All pains should be taken to construct this portion with hard consolidated impervious gravel on which the revetment should be reconstructed conforming to standard specifications and well wedged to the back.

(3) The rear slope in this portion of the bund may be kept at $2\frac{1}{2}:1$ using the excavated material from the weir channel as a casing material for the rear part of the dam.

(4) In the two breaches in grades 28 and 29 and in grades 19, 20 and 21, the bund profile should be, front slope to 2 : 1 and rear slope $2\frac{1}{2}:1$ with a berm at the back ending in a riprap toe. In the second breach in grades 19, 20 and 21, a puddle core wall and a puddle trench are both necessary. And the greatest care for effecting a hard consolidated water-proof junction with the old bund should be taken.

(5) At the Thuppadahalli site, Chinnahagari has the following upper major tanks :—

Bharamasagara	..	677 units.
Anaji ..	..	1,026 „

Thuppadahalli is the 3rd tank in series.

The Chinnahagari valley being subjected to more intensive rainfall than the Sangenahalli tank, an increased weir length of 425 feet with a 4 feet depth spill-way should be provided, calculated on the basis of a co-efficient discharge of 350 instead of 300 in the Ryves Formula :—

$$Q = 350 \times 198^{2/3} - 1/5 \times 350 \times 65^{2/3} = 10{,}768 \text{ cusecs}$$

giving $L = \frac{10768}{3.3 \times 4\frac{1}{2}} = 434$ feet or say 425 feet length may be provided with a 4 feet depth of spill.

As in the case of Sangenahalli tank, it is desirable to have a breaching section of an additional 100 feet. What we

propose is, that a second compartment of masonry weir of 60 feet may be constructed and a breaching section of about 100 feet provided next to it.

(6) The free board in this tank above the maximum water level is only 3 feet. Why this was kept as 3 feet while in the case of Sangenahalli tank with less favourable rainfall, 4 feet was provided, is not quite clear. In both the cases the bund-top level should be 5 feet above the maximum water level so that the final finished level of the top bund at Thuppadahalli should be R. L. 2025.00 instead of R. L. 2023.00 as is now sanctioned.

(7) It is suggested that the crest of the weir for a length of 250 feet may be lowered to R. L. 2013.00 to impound a reduced storage of water. It may, perhaps, take 5 or 6 years to develop full irrigation and there would be a chance to study the bund during that period.

Cost of making good the Damages

	Rs.
(*a*) Cost of repairs as per Executive Engineer's estimate for repair of breaches, etc. ..	90,000
(*b*) Cost of providing casing material for end flank grades ..	2,500
(*c*) Removal of revetment, consolidation after stepping, grips and gravel backing and reconstruction of revetment ..	31,000
(*d*) Extra work involved in the two breaches for revised profile ..	4,000
(*e*) Miscellaneous, *viz.*, riprap fill, breaching section, increased free board and extending weir ..	6,000
	1,33,500
or say ..	1,35,000

Note.—(1) This abstract of cost would have to be finalised after obtaining correct quantities and rates from the Executive Engineer.

(2) This figure does not take into account cost of making good damages to lands, etc.

In conclusion, it may be stated that the Thuppadahalli tank breach was caused due to :

(*a*) heavier rainfall than normal ending in rapid filling of the lake ;

(*b*) very inadequate free board at the time of the breach ;

(*c*) incomplete revetment construction ;

(*d*) poor black soil with which the bund is made ;

(*e*) want of consolidation ; and finally,

(*f*) want of fore-thought on the part of the Engineers at the spot, who, had they only reduced the weir crest by 3 feet to R. L. 2013.00 for the full 365 feet length of the weir on the 28th October 1953 when the lake was full and discharging, this tank could have been saved.

It is further to be stated that in the case of both these tanks which have breached, there is no question of the tanks having failed due to unprecedent heavy rainfall. On the other hand, during the year 1953 October rains, the Sangenahalli catchment area received only monsoon rains of a normal nature, and it failed even before it filled. In the case of Thuppadahalli tank, though during the second fortnight of October 1953 there was heavier rainfall, it is to be stated that this cannot be unprecedented.

We see from Sri J. M. Imam's note that in 1933 there was a heavy rainfall of about 7" in Jagalur and there was over-topping of water in Jagalur tank. When asked how the tank bund withstood the overflowing on the bund, Sri Imam told us that the bund was so well constructed and besides, immediate precautionary measures were taken by breaching the tank bund in one of the flanks. We have evidence of this kind of heavy rainfall in 1948 when there were flood damages to this very work. From a perusal of the report of the then Sub-Division Officer in charge of No. 2 Sub-Division in Jagalur dated 6th August 1948, we find that the Sub-Division Officer has reported that "the magnitude of the flood can be imagined when it has flooded the shandy maidan of Bilichodu village and

that there was a margin of only 1½' to the top of the road surface at Bilichodu bridge submerging even the girders spanning it by 1½ feet." Again in the year 1951, there were heavy rains on 5th June 1951 in the same series causing damages to the Gadimakunte tank works which were in progress. From a report dated 6th June 1951 of the Assistant Engineer, Jagalur, to the Executive Engineer, Davangere, we find that due to a very high intensity of rainfall in the catchment area of the tank, the tank suddenly received an inflow of eight feet of water in the course of four hours between 5 P.M. and 9 P.M. In the second para of the same report, we find that the difference in capacity between R. L. 127.00 to R. L. 134.68 is 336 units and this inflow has come into the tank within a period of *four* hours. This has given a rate of flow of 6,000 cusecs against the maximum of 3,920 cusecs calculated for the weir discharge. There has been rain almost every day from 18th May 1951 and the sudden flow on 5th June 1951 is in all probability due to many of the saguvalikattes in the catchment area giving way in addition to the two tanks, *viz.*, Hoskere and Kyasenahalli which were discharging from 4th June 1951.

Thus, sudden and heavy rainfall in this area is not a new phenomena this year only, though this year's record has beaten the previous 35 years' average. Unfortunately they have not taken notice of continuous rainfall in the valley during the month prior to 28th October 1953.

As such warnings of heavy rainfall in previous years leading to breaches are not uncommon in this valley and the Engineers at the spot had a two days' warning to take remedial measures before the tank breached on the morning of 30th October 1953.

It is clear that in the case of both the tanks the work from start to finish has not been done according to specifications. It is a question how the disbursing officers allowed full rates to be passed on various items of work done, such as earth work, consolidation and revetment construction, etc., when these two important items did not come up to any standard of work. It is a question whether these need be considered as over-payment for inferior quality work.

If the coming monsoons should not lead to greater damages leading to greater cost of restoration, it is essential to rush through these works and complete them in good time. The Committee, therefore, feels that the present set of officers and subordinates who do not seem to be having much of experience in earth work construction should be replaced and men of known experience and capacity have to be kept in charge of both these tanks when the restoration work is taken on hand.

The landowners who have suffered have given petitions to us praying for proper compensation for the loss they have sustained due to loss of crops and also for the damages caused to their lands and wells. We recommend that they may be given some relief on the basis of the damage assessed by the local Revenue Officers.

When we visited Thuppadahalli tank works, residents of Kuradi, and Hemmanabethur villages of Davangere Taluk, whose lands come under submersion gave us a petition bitterly complaining of the inordinate delay in building up acquisition records and in arranging to pay the compensation amount. On enquiry we were told the matter is now pending in the Revenue Sub-Division Office, Davangere. The Deputy Commissioner, Chitaldrug District, may be asked to instruct the Revenue Sub-Division Officer, Davangere, who is also the Land Acquisition Officer to expedite the award proceedings.

Finally, we suggest that in the case of such special works, there should not be frequent change of officers as we see in these two works. We also suggest that officers of known experience, capacity and integrity should be posted.

We thank the Government for all the facilities they provided us and also the various local officers who made our stay comfortable at the time of the inspection of the work.

We also wish to place on record the services rendered by Sri N. B. Basappa, whose services were placed at the disposal of the Committee.

We place below various petitions, anonymous letters, pseudonymous petitions and letters received by us.

L. SIDDAPPA.
H. R. GURUV REDDY.
C. R. IYENGAR.

NOTE BY SRIYUTS L. SIDDAPPA AND H. R. GURUV REDDY

Of the three members of the Committee, we two, *viz.*, Sri L. Siddappa and Sri H. R. Guruv Reddy, wish to add the following for consideration of Government.

It is clear from the conclusions reached by us that in the case of both the tanks the work from start to finish has not been done according to specifications. This leads us to an inference that the Engineer Officers who were entrusted with the task of executing these two important new works have, either, as is alleged by the residents of some of the villages surrounding Sangenahalli tank, been corrupt and have allowed higher rates for manifestly inferior work with a view to share the profits or they have been grossly negligent in their duties, thus causing great loss to the State Exchequer.

The land-owners below these two tanks have also suffered great loss owing to sudden onrush of water. Crops on their lands have been washed away, top soil on cultivated lands has been eroded making the lands unfit for cultivation for one or two years to come and in some instances a lot of silt has been deposited in irregular shapes. We were also told that many irrigation wells have been silted up. We have not assessed the damage caused to the land owners due to the loss of crops, and damage done to the lands and kapile wells as it was outside the scope of our enquiry and also as the local Revenue Authorities have made an assessment of the same. When we were in Jagalur, the Amildar showed us a copy of the damage report he has made to the higher authorities and it looked to us to give a fair estimate of the damages caused to the land owners.

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Whether the Engineer Officers allowed this bad work out of corrupt motives or due to indifference or negligence in the discharge of their duties, we are of opinion they are equally guilty and they should not be allowed to go unpunished. We leave it to Government to cause such further enquiry as they deem fit to apportion the guilt among the several officers and officials who were responsible for the preparation of the projects for checking the same and for executing the works connected therewith as we see that so many officers are connected with them. In addition to any disciplinary action that may be taken against them, the officers responsible have to be made to pay at least a token amount out of the loss that Government will have to incur to make good the damages. Our proposals for punishment and for recovery of the losses may seem very drastic. In building up New India everyone connected with developments works whether official or non-official must work with a patriotic spirit that he is working for the advancement of the country. In this connection we may quote a passage from the Speech of Dr. S. Radhakrishnan, Vice-President of India, on the occasion of Opening the Staff Colony of Kandla Port on the 15th January 1954 :

> " When the great ancient structures were constructed, a different spirit animated the workers and organisers. There was an element of sanctity, there was a spirit of dedication, a sense of pride that they were working for a cause which will redound to the credit of the country. That sense of dedication, that sense of service, the pride that we are constructing something, which will for many centuries remain great and useful and cater to the needs of the people must also animate the people who are working in our country now."
>
> * * *
>
> " What is necessary in these matters is that the workers, the organisers and the authorities should all work together with a single minded devotion that they are doing something which is of great national importance. That sense of pride must overtake all who

are engaged on these projects without considering how much it will pay and how long they have to work—seven or eight hours a day."

* * *

"Great public projects and small private character will never go together."

If instead of bringing to bear this patriotic spirit in their work, our officers engaged on such projects are either corrupt or indifferent, resulting in great loss to the State and great hardship to the people, we are of opinion that no consideration should be shown to them. Government on their part have shown great anxiety to push through these works as expeditiously as possible and in as sound a manner as is necessary can be seen from the fact that as soon as they accorded sanction to Sangenahalli Tank Works in January 1946, took care to constitute a Special Irrigation Division, to be solely in charge of these special works though in the original projects of these works, provision was made for a mere Sub-Division. All the hopes entertained by Government for the expeditious and sound execution of these works were shattered to pieces when we see that works which were scheduled to be completed within a period of five or six years from the date of sanction, protracted for a period of over eight years with the costs rising to three times the estimated costs, and with this disastrous result. It has been a great disappointment to the people of the locality who are to be benefited by these projects that just at a time when they were expecting their hopes were almost realised to find these tanks have breached. A feeling of frustration has overtaken the people of the locality and they have begun to doubt whether these works would be brought to a successful completion at all. We suggest that Government should take all possible measures to dispel this feeling by replacing the entire staff connected with these works by posting very competent and honest officers as recommended by us elsewhere in this report.

L. SIDDAPPA.

H. R. GURUV REDDY.

APPENDIX I

EXTRACT OF *Mysore Gazette*, DATED 5TH NOVEMBER 1953.

Season Report for the 44th week ending with the 31st Saturday in October 1953.

Rainfall upto a.m. on Saturday the 31st October 1953

District and Station	*This week*	*Last 35 years' average for the corresponding week*	*Up to end of the week from 1st January 1953*		
			This year	*Average of past 35 years*	*Excess (plus) or deficit (—) of Col. 4 compared with Col. 5*
			CHITALDRUG.		
Chitaldrug ..	5.84	0.52	18.33	21.62	—3.29
Challakere ..	6.60	0.38	18.26	15.99	+2.27
Hiriyur ..	4.11	0.61	28.57	19.23	+4.34
Molakalmuru ..	4.90	0.40	22.57	21.44	+1.13
Holalkere ..	6.33	0.40	34.07	21.99	+12.08
Davangere ..	6.01	0.48	30.59	22.99	+7.60
Jagalur ..	7.07	0.48	23.93	19.76	+4.17
Hosadurga ..	4.05	0.48	28.89	20.43	+8.46
Harihar ..	2.90	0.39	24.07	18.98	+5.09
District average.	5.31	0.45	24.92	20.27	+4.65

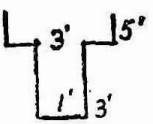
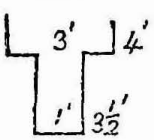
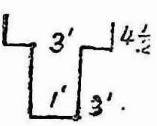
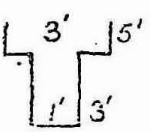
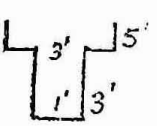
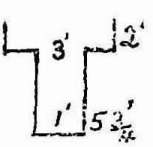
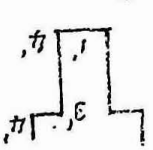
Appendix II.

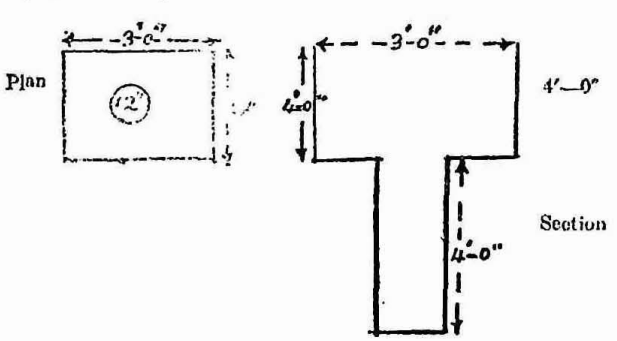
Results of Absorption Test conducted on Sangenahalli Tank bund by means of bore holes.

Date	*Number of grade*	*Time*	*Depth of water in bore hole*	*Rate of absorption per hour—depth in inches*	*Remarks*
19-12-1953	30th	11.30 A.M.	75″	..	Pits of 3′×3′×2′ excavated and bore holes to a depth of about 6′ below the top 2 feet was done and water poured in the bores and results are noted. The absorption in the initial stage which is more is due to initial absorption in the top layers which are gravelly above F.T.L. level.
		12.30 P.M.	72½″	2½″	
		1.30 P.M.	70″	2½″	
		2.30 P.M.	67½″	2½″	
		3.30 P.M.	65″	2½″	
		4.30 P.M.	63″	2″	
		5.30 P.M.	61″	2″	
19-12-1953	20th	11 A.M.	72″	..	
		12 NOON	62″	10″	
		1 P.M.	58″	4″	
		2 P.M.	55″	3″	
		3 P.M.	53″	2″	
		4 P.M.	51″	2″	
		5 P.M.	49″	2″	
19-12-1953	17th	11.30 A.M.	72″	..	
		12.30 P.M.	62″	10″	
		1.30 P.M.	52″	10″	
		2.30 P.M.	42″	10″	
		3.30 P.M.	36″	6″	
		4.30 P.M.	33″	3″	
		5.30 P.M.	31″	2″	
20-12-1953	25th	12.30 P.M.	72″	..	
		1.30 P.M.	60″	12″	
		2.30 P.M.	48″	12″	
		3.30 P.M.	43″	5″	
		4.30 P.M.	39″	4″	
		5.30 P.M.	35″	4″	
20-12-1953	24th	1.50 P.M.	60″	..	
		2.50 P.M.	32″	28″	
		3.50 P.M.	29″	3″	
		4.50 P.M.	27″	2″	
		5.50 P.M.	25″	2″	
20-12-1953	13th	2.00 P.M.	72″	..	
		3.00 P.M.	45″	27″	
		4.00 P.M.	39″	6″	
		5.00 P.M.	34″	5″	
		6.00 P.M.	32″	2″	

APPENDIX III

Results of tests conducted on Thuppadahalli Tank for consolidation of bund tests conducted on 20th December 1953.

Grade	Dimensions of test pit	Total depth of pit	Depth of water put in	Initial Time	Drop in water level	Depth in inches per hour
22		8'—0"	7'—0"	10.30 A.M.	1'5"@1.40 P.M. @3.00 P.M. 1'8" @ 5.10 P.M.	3"
24		7'—6"	6'—4"	11.20 A.M.	9" @ 1.40 P.M. 12" @ 5.10 P.M.	2"
26		7'—6"	6'—6"	12 NOON	2'8" @ 1.40 P.M. 2'10" @ 5.15 P.M.	7.6"
34		8'—0"	6'—4"	1.40 P.M.	8" @ 3.10 P.M. 12" @ 5.20 P.M.	5.2"
36		8'—0"	6'—10"	3.20 P.M.	7" @ 5.25 P.M.	3½"
38		7'—9"	7'—0"	3.35 P.M.	4" @ 5.26 P.M.	2½"
40		8'—0"	7'—4"	3.53 P.M.	4" @ 5.28 P.M.	2⅝"



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